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Developing Trends in Household Size for Use in Population Estimates

By Population Unit

THE OFFICE OF FINANCIAL MANAGEMENT'S (OFM) April 1 population estimates program develops estimates for local jurisdictions that are used for revenue allocations and program administration (RCW 43.62.020). Household size trends are an important variable in the Housing Unit Estimation Method used by OFM. This Brief illustrates a regression procedure using administrative data that can be used to update household size in the Housing Unit Method.

Housing Unit Estimate Method

The Housing Unit Method is used to estimate city populations. A simplified version is shown below:

Current City Housing X Occupancy Rate X Avg. Persons Per Occupied House = Persons in Houses

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Current count of persons in nursing homes, correctional, other facilities = Persons in Facilities

Total City Population

- *OFM's annual population estimates are benchmarked to the most recent federal decennial census and use federal census data and definitions.*
- The 1990 federal census housing counts are updated on the basis of new constructions, demolitions and annexations.
- The 1990 federal census *measures of occupancy rates and average persons per household are updated*, when possible, on the basis of available administrative or survey data.

Criteria to ensure accuracy are important. Cities and towns share a set revenue fund each year. Population increases reduce the per capita allocation to all cities. All population estimates must be as fair and as accurate as possible. Small shifts in average household size and vacancy rates in moderate to large cities have a dramatic impact on the allocations to other cities.

At the state and local level, household size has changed considerably over the decades. Changes in household size can make a large difference in population estimates when the Housing Method is used. Trending household size from historical experience may or may not be appropriate given the changes in household size in the past (Table 1) and variations in household size at the local level.

Table 1
Decade Change in Household Size by Structure Type: 1970-80 and 1980-90

	Average Household Size			Percent Change	
	1970	1980	1990	1970-80	1980-90
State of Washington					
All Housing	2.9737	2.6086	2.5348	-12.3	-2.8
Single Family	3.2655	2.8729	2.7969	-12.2	-2.6
Multi-Units	1.9286	1.8633	1.8788	-3.4	0.8
Mobile Homes/Spec.	2.4332	2.3826	2.4134	-2.1	1.3

While the decline in household size at the state level slowed markedly during the 1980s, Clallam, Jefferson, and Pacific Counties continued to have large declines in household size during the 1980s due to increasing retirement-age populations. Some counties in Eastern Washington, such as Adams, Franklin, and Yakima showed increases in household size due to increasing Hispanic populations through the 1980s and 1990s. State or national trends cannot be assumed to fit local areas.

One solution is to identify administrative data that reflect the *trends (change) in household size for local areas since the last census*. Administrative data are both real and current and can be used to determine whether historical trends should be carried forward or changed.

Table 2
Regression Equation Predicting Change in Persons per Household for Counties All Housing

Regression Statistics:	**Multiple R = 0.8832**	**R Squared = 0.7801**	**F = 41.39**	**Cases = 39**
Dependent Variable (x):	1980 to 1990 Change in Persons *per all occupied housing*			
Independent Variables (y):	(1) 1980 to 1990 change in public K-8 enrollment *per all housing*	(2) 1980 to 1990 Change in the sum of annual births for 4 years prior to prediction date *per all housing*	(3) 1980-1990 Change in Persons age 65 years and over *per all housing*	

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Initial studies are promising. The multiple regression equation shown in Table 2 provides reasonably accurate predictions of change in household size for the vast majority of counties (Table 3). Thus far, relationships for single family units or mobile homes and trailers are not as strong as those for all housing combined. Further evaluation and testing is continuing.

Estimated Household Size Trends : 1990-2000

Most of the 1990 PPH predictions, based on the coefficients in Table 3 had less than two percent differences from actual 1990 census-based PPHs. About 60 percent of counties had less than one percent error and only 15 percent had more than two percent error. A similar analysis was made for the 1970-1980 decade, which showed that prediction errors did not generally carry over from decade to decade. For example, Benton County had the greatest 1980-90 error, 2.94 percent, yet its 1970-80 error was only 0.79 percent. Yakima County's error was –2.59 percent for 1980 but only 0.02 percent for 1990. This means that the PPH estimates for 1999 shown in the next section are likely to be less than two percent higher or lower than actual household size, but we cannot say for sure how much the difference is for a specific area. This is true for all statistically based estimations including data based on sampling.

Estimates of PPH for the state and each of the counties, by year, are presented in Table 4. The state numbers are the result of the model, and are not directly related to the individual county numbers; in other words, weighting county PPHS by numbers of housing units might result in a slightly different set of state household sizes.

Most PPHs decline over time, though not always uniformly. For example, the model has most county PPHs falling from 1990 to 1991 and then gaining slightly in 1992. There were 1992-93 gains as well, but for fewer areas. This might be influenced by the rise in births that peaked around 1990. The reader should keep in mind that this is a statistical model subject to yearly fluctuations in administrative data and that the important thing is the general trend shown by the results.

Table 3
Actual and Predicted Persons Per Household Counties Ranked by Level of Model Error

	Actual Persons per Household			Predicted		
County	1980	1990	Difference	Difference	PPH	Percent Error
Washington	2.60857	2.53476	-0.07381			
Benton	2.79709	2.65164	-0.14545	-0.06755	2.72954	2.94
Douglas	2.75907	2.67689	-0.08218	-0.01535	2.74372	2.50
Garfield	2.59554	2.39479	-0.20075	-0.14358	2.45196	2.39
Pend Oreille	2.80879	2.60295	-0.20584	-0.14672	2.66207	2.27
Stevens	2.90697	2.73179	-0.17518	-0.11857	2.78840	2.07
Chelan	2.48269	2.48632	0.00363	0.04846	2.53115	1.80
Jefferson	2.45369	2.30891	-0.14478	-0.10351	2.35018	1.79
Wahkiakum	2.77236	2.47615	-0.29621	-0.25887	2.51349	1.51
San Juan	2.29461	2.24886	-0.04575	-0.02444	2.27017	0.95
Spokane	2.57894	2.47472	-0.10422	-0.08285	2.49609	0.86
Walla Walla	2.54109	2.49549	-0.04560	-0.02531	2.51578	0.81
Lincoln	2.57255	2.43079	-0.14176	-0.12324	2.44931	0.76
Asotin	2.56615	2.47265	-0.09350	-0.08143	2.48472	0.49
Columbia	2.52535	2.43679	-0.08856	-0.08302	2.44233	0.23
Skamania	2.78964	2.69211	-0.09753	-0.09206	2.69758	0.20
Yakima	2.77112	2.80393	0.03281	0.03348	2.80460	0.02
Thurston	2.64412	2.55302	-0.09110	-0.09238	2.55174	-0.05
Snohomish	2.76061	2.67935	-0.08126	-0.08549	2.67512	-0.16
Whitman	2.46879	2.38676	-0.08203	-0.08697	2.38182	-0.21
Grant	2.79864	2.74074	-0.05790	-0.06583	2.73281	-0.29
Okanogan	2.66737	2.58772	-0.07965	-0.08761	2.57976	-0.31
Pierce	2.65859	2.62306	-0.03553	-0.04581	2.61278	-0.39
King	2.48679	2.39822	-0.08857	-0.09845	2.38834	-0.41
Kitsap	2.68202	2.64693	-0.03509	-0.04862	2.63340	-0.51
Whatcom	2.59016	2.53244	-0.05772	-0.07298	2.51718	-0.60
Ferry	2.85670	2.69782	-0.15888	-0.17892	2.67778	-0.74
Clallam	2.53741	2.40071	-0.13670	-0.15600	2.38141	-0.80
Franklin	2.88169	3.03403	0.15234	0.12671	3.00840	-0.84
Grays Harbor	2.59656	2.48134	-0.11522	-0.13615	2.46041	-0.84
Kittitas	2.39764	2.32514	-0.07250	-0.09218	2.30546	-0.85
Lewis	2.67323	2.59970	-0.07353	-0.09759	2.57564	-0.93
Cowlitz	2.66188	2.55875	-0.10313	-0.13920	2.52268	-1.41
Skagit	2.56563	2.54947	-0.01616	-0.05236	2.51327	-1.42
Klickitat	2.72106	2.64090	-0.08016	-0.11859	2.60247	-1.46
Island	2.67060	2.61486	-0.05574	-0.09495	2.57565	-1.50
Pacific	2.44654	2.34992	-0.09662	-0.13523	2.31131	-1.64
Adams	2.91132	2.94047	0.02915	-0.02310	2.88822	-1.78
Clark	2.76247	2.66247	-0.10000	-0.15009	2.61238	-1.88
Mason	2.54583	2.51624	-0.02959	-0.09007	2.45576	-2.40

Table 4
Estimated Population per Household: Washington state Counties: 1990-2000

Area	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Washington State	2.535	2.497	2.505	2.511	2.507	2.501	2.495	2.489	2.480	2.470	2.457
Adams	2.940	2.914	2.901	2.912	2.908	2.882	2.860	2.826	2.831	2.838	2.830
Asotin	2.473	2.432	2.432	2.422	2.411	2.395	2.385	2.361	2.358	2.319	2.303
Benton	2.652	2.619	2.635	2.643	2.633	2.622	2.594	2.580	2.561	2.551	2.530
Chelan	2.486	2.463	2.481	2.496	2.508	2.517	2.525	2.529	2.520	2.508	2.502
Clallam	2.401	2.351	2.346	2.339	2.317	2.302	2.280	2.269	2.249	2.220	2.201
Clark	2.662	2.617	2.620	2.628	2.621	2.615	2.616	2.616	2.603	2.600	2.594
Columbia	2.437	2.403	2.397	2.390	2.367	2.381	2.356	2.315	2.291	2.275	2.251
Cowlitz	2.559	2.526	2.516	2.521	2.513	2.500	2.493	2.483	2.481	2.472	2.451
Douglas	2.677	2.614	2.653	2.659	2.662	2.632	2.621	2.614	2.594	2.580	2.551
Ferry	2.698	2.650	2.650	2.636	2.637	2.593	2.580	2.529	2.499	2.485	2.447
Franklin	3.034	2.990	3.016	3.020	3.013	3.022	3.004	2.966	2.963	2.955	2.975
Garfield	2.395	2.338	2.345	2.302	2.325	2.303	2.301	2.319	2.317	2.306	2.284
Grant	2.741	2.715	2.735	2.723	2.714	2.724	2.705	2.706	2.699	2.698	2.687
Grays Harbor	2.481	2.448	2.454	2.465	2.449	2.434	2.423	2.401	2.387	2.370	2.352
Island	2.615	2.571	2.570	2.563	2.555	2.545	2.536	2.520	2.496	2.485	2.467
Jefferson	2.309	2.272	2.260	2.257	2.243	2.241	2.219	2.202	2.193	2.179	2.160
King	2.398	2.361	2.368	2.377	2.379	2.378	2.378	2.379	2.376	2.370	2.360
Kitsap	2.647	2.603	2.606	2.597	2.590	2.575	2.568	2.561	2.543	2.527	2.500
Kittitas	2.325	2.288	2.295	2.299	2.297	2.286	2.270	2.260	2.237	2.229	2.215
Klickitat	2.641	2.575	2.571	2.578	2.572	2.555	2.557	2.521	2.485	2.471	2.453
Lewis	2.600	2.562	2.559	2.544	2.523	2.504	2.489	2.471	2.448	2.440	2.420
Lincoln	2.431	2.379	2.361	2.369	2.375	2.365	2.357	2.339	2.316	2.303	2.280
Mason	2.516	2.469	2.472	2.471	2.463	2.456	2.454	2.444	2.428	2.419	2.413
Okanogan	2.588	2.556	2.555	2.569	2.579	2.566	2.552	2.529	2.515	2.498	2.481
Pacific	2.350	2.308	2.305	2.294	2.300	2.287	2.283	2.269	2.257	2.245	2.230
Pend Oreille	2.603	2.578	2.593	2.602	2.601	2.587	2.583	2.556	2.520	2.486	2.446
Pierce	2.623	2.586	2.589	2.589	2.575	2.562	2.551	2.543	2.534	2.521	2.506
San Juan	2.249	2.216	2.203	2.200	2.204	2.192	2.185	2.174	2.177	2.178	2.141
Skagit	2.549	2.506	2.514	2.521	2.522	2.505	2.500	2.486	2.485	2.487	2.471
Skamania	2.692	2.631	2.644	2.649	2.620	2.598	2.585	2.552	2.529	2.502	2.498
Snohomish	2.679	2.636	2.659	2.673	2.669	2.664	2.657	2.658	2.652	2.638	2.622
Spokane	2.475	2.451	2.457	2.462	2.446	2.436	2.426	2.410	2.401	2.390	2.379
Stevens	2.732	2.677	2.678	2.665	2.654	2.630	2.617	2.608	2.574	2.555	2.542
Thurston	2.553	2.511	2.517	2.513	2.499	2.484	2.465	2.450	2.432	2.413	2.390
Wahkiakum	2.476	2.454	2.455	2.465	2.449	2.459	2.454	2.463	2.461	2.418	2.389
Walla Walla	2.495	2.464	2.479	2.510	2.513	2.510	2.502	2.480	2.466	2.437	2.425
Whatcom	2.532	2.491	2.493	2.498	2.492	2.485	2.476	2.469	2.464	2.466	2.455
Whitman	2.387	2.350	2.351	2.359	2.345	2.343	2.336	2.325	2.317	2.298	2.282
Yakima	2.804	2.786	2.800	2.825	2.839	2.845	2.849	2.841	2.840	2.823	2.812

Ranked changes in estimated PPH from 1990 to 2000 are shown in Table 5. The ranking is from positive to negative. Only Chelan and Yakima counties posted slight estimated PPH gains, while Skamania and Ferry counties dropped about 1/5 of a person per household over the nine years.

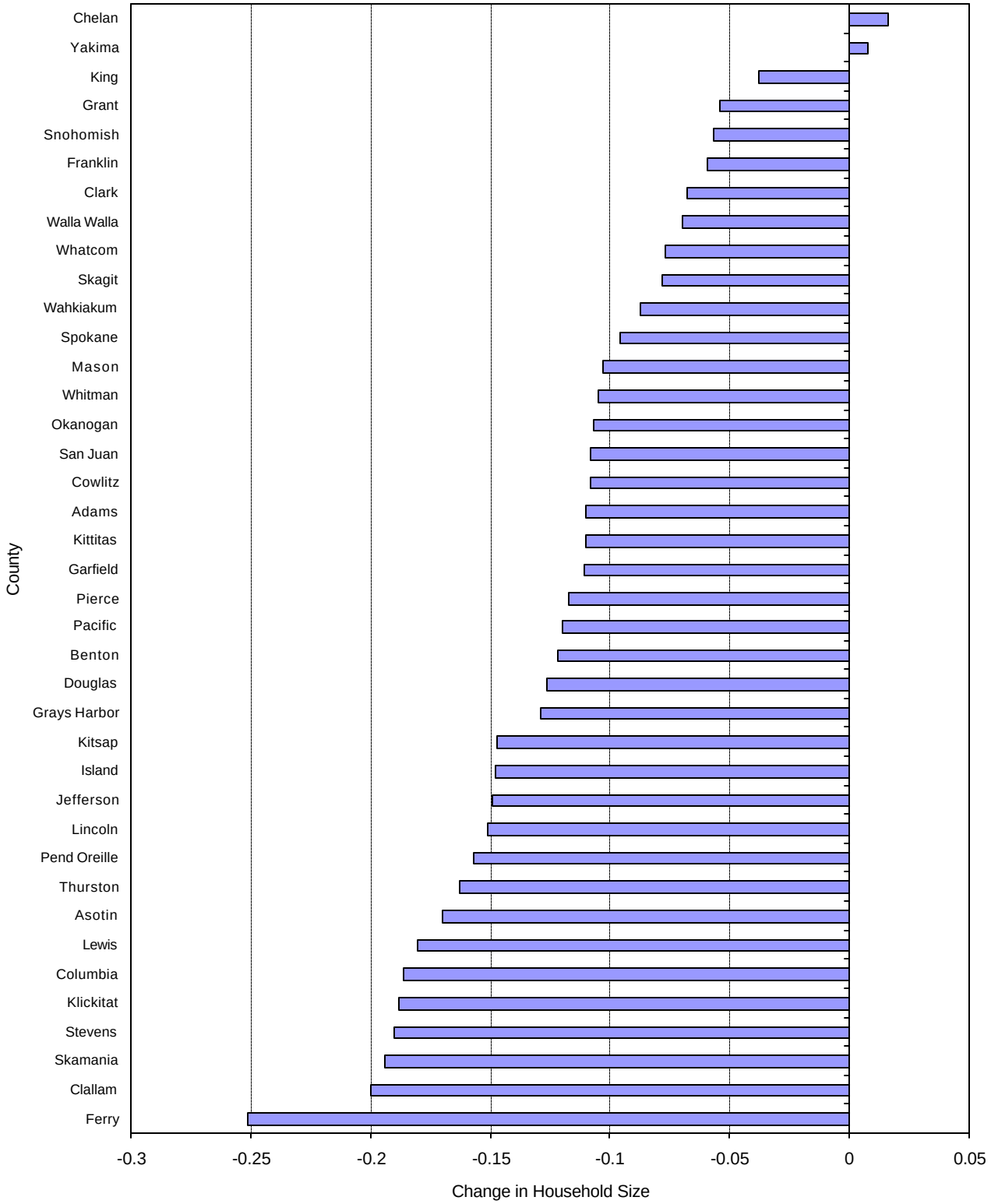
Data in Table 5 are graphed in Figure 1, and indicate an S-shaped pattern with a clustering around 1/10 of a person per household loss and accelerating deviations from this level in each direction.

Table 5
Ranked Change in County PPH 1990-00

County	1990	2000	Difference
Chelan	2.486	2.502	0.016
Yakima	2.804	2.812	0.008
King	2.398	2.360	-0.038
Grant	2.741	2.687	-0.054
Snohomish	2.679	2.622	-0.057
Franklin	3.034	2.975	-0.059
Clark	2.662	2.594	-0.068
Walla Walla	2.495	2.425	-0.070
Whatcom	2.532	2.455	-0.077
Skagit	2.549	2.471	-0.078
Wahkiakum	2.476	2.389	-0.087
Spokane	2.475	2.379	-0.096
Mason	2.516	2.413	-0.103
Whitman	2.387	2.282	-0.105
Okanogan	2.588	2.481	-0.107
Cowlitz	2.559	2.451	-0.108
San Juan	2.249	2.141	-0.108
Adams	2.940	2.830	-0.110
Kittitas	2.325	2.215	-0.110
Garfield	2.395	2.284	-0.111
Pierce	2.623	2.506	-0.117
Pacific	2.350	2.230	-0.120
Benton	2.652	2.530	-0.122
Douglas	2.677	2.551	-0.126
Grays Harbor	2.481	2.352	-0.129
Kitsap	2.647	2.500	-0.147
Island	2.615	2.467	-0.148
Jefferson	2.309	2.160	-0.149
Lincoln	2.431	2.280	-0.151
Pend Oreille	2.603	2.446	-0.157
Thurston	2.553	2.390	-0.163
Asotin	2.473	2.303	-0.170
Lewis	2.600	2.420	-0.180
Columbia	2.437	2.251	-0.186
Klickitat	2.641	2.453	-0.188
Stevens	2.732	2.542	-0.190
Skamania	2.692	2.498	-0.194
Clallam	2.401	2.201	-0.200
Ferry	2.698	2.447	-0.251

When results of the 2000 census appear in 2001, the model will be re-calibrated using 1990-2000 data for potential use in post-2000 population estimates based on housing stock change.

Figure 1. Estimated Change In Household Size: Washington Counties, 1990-2000.



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